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project record

A FIELD EVALUATION  
**HELICOPTER  
MOUNTED  
GRENADE  
DISPENSER  
AND  
INCENDIARY  
GRENADES**

ED&T 1710  
FIRING & LINE HOLDING DEVICES

**AUGUST 1974**



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*U.S. Department of Agriculture  
Forest Service  
Equipment Development Center  
Missoula, Montana*

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PROJECT RECORD

A FIELD EVALUATION:

HELICOPTER MOUNTED GRENADE DISPENSER AND INCENDIARY GRENADES

ED&T 1710

FIRING AND LINE HOLDING DEVICES

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August 1974

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## INTRODUCTION

The objective of ED&T 1710, Firing and Line Holding Devices, is to improve safety and efficiency in prescribed burning and wildfire control through the development of equipment for firing and line holding. There has been a need in the past to burn out and back-fire sections of fireline to insure control of large wildfires. To do this on the ground is slow and at times can be quite hazardous. In many cases an airborne system seemed to be the answer, but a safe functional system has not been available. At times systems were "jury rigged" to get the job done but these left something to be desired with respect to aircraft and aircrew safety.

The beneficial use of fire in other work such as rehabilitation of big game winter range has recently increased the interest in airborne firing systems which would lower the cost of burning in rugged, remote areas. An investigation of available systems and methods for airborne ignition was conducted in the initial portion of the project. This work and the general requirements for an airborne ignition system are reported in a project record entitled "Airborne Ignition System", ED&T 1710 dated January 1973, along with results of a brief functional test of the system selected.

This report covers field evaluation of the Fairchild-Hiller Corporation XM118 Grenade Dispenser and two types of incendiary grenades and concludes work in ED&T 1710.

## PURPOSE AND SCOPE

Preliminary plans called for conducting the evaluations in conjunction with big game range rehabilitation projects in the Northern Region (R-1) and on wildfires in the California Region (R-5). The objectives of the evaluation were:

1. Determine how the airborne system compares in cost and effectiveness with current ground ignition methods.

2. Determine operational procedures for the aerial system such as drop

height (above ground), flying speed, drop interval, flight patterns, field loading time, and dispenser capacity desirable for various fuel types.

3. Make a preliminary assessment of the suitability of the dispenser for aerial burnout operations on wildfires.

4. Determine the extent of additional testing needed in various fuel types to qualify the system for field use.

The evaluations eventually covered three types of use including wildfires, big game browse burning and slash burning.

## DESCRIPTION OF EQUIPMENT

The AN-M14 incendiary hand grenade is a cylindrical metal container, 2-1/2 in. in diameter and 4-1/2 in. high, filled with 26 oz. of thermate and fitted with an M201A1 grenade fuze. The fuze has a delay time of about 2 seconds and the thermate burns for 30-45 seconds at approximately 4,000°F and produces a small amount of molten iron.

The American Service Products (ASP) grenade is packaged the same as the military grenade and contains a magnesium and latex material. A M206A explosive fuze is used which ignites and spreads the material over a 300-400 foot diameter area. This fuze is a Class A explosive which creates some shipping problems.

The XM118 dispenser was designed and built by the Fairchild-Hiller Corp. to drop colored smoke grenades for the military.

Mounting brackets and controls for the dispensers were designed and built by MEDC and were used on a Fairchild-Hiller FH 1100 and on Bell 47G3B helicopters. A military MA-4 aircraft bomb rack was used to attach the dispensers to the mounting bracket.

A waiver to allow the use of this type of equipment was obtained from the FAA through R-1 Air Operations. Also, permission to allow firing from a helicopter was obtained from the Forest Service Division of Fire Management, Washington Office.



## WILDFIRE USE

After a brief functional test of the XM118 dispenser and AN-M14 incendiary grenades early in 1972, it was felt that the best chance for further evaluation would be to use the system for burning on a wildfire. On July 31 the Bureau of Land Management (BLM) in Alaska made an inquiry through the Boise Interagency Fire Center (BIFC) on the availability of some type of aerial firing system. They were referred to the Missoula Equipment Development Center (MEDC) and arrangements were started to get equipment to Alaska and to obtain a supply of grenades from the military. The BLM had several large fires burning northwest of Fairbanks on which a considerable portion of control effort could be accomplished by burning out to natural barriers.<sup>1/</sup>

The equipment was taken to Fairbanks and mounted on the BLM owned FH 1100 helicopter (fig. 1). Some small modifica-

tions had to be made as this original unit was designed to mount on the small Bell 47G series helicopters.

### Bridge Fire (No. 8815)

The first grenades were dropped along a section of handline on the Bridge Fire located near Allakaket. This drop was mainly to determine operational procedures and how the AN-M14 grenades performed in the Alaska fuel type. The drop was successful and on the following day with a favorable wind, approximately 10.5 miles of line were burned out along the west side of the fire using the Kanuti River as control line. In just over 4 hours, 13 runs were made and 305 of these grenades were dropped. Over an hour of this time was spent on a trip to Allakaket for fuel and additional grenades. The crew, as in most of the evaluation, consisted of a firing project leader, helicopter pilot, two ground crewmen (one of which acted as safety officer), and a data recorder.



*Figure 1.--Dispensers mounted on BLM FH 1100 helicopter.*

<sup>1/</sup> Incendiary grenade dispenser evaluated in Alaska. Fire Management, Spring 1973, Vol. 34, No. 2.





The skid supports on the FH 1100 fold in slightly upon takeoff so the dispensers had to be mounted well underneath the helicopter. This made it necessary to remove the rack for loading (fig. 2). After a routine was worked out, the dispensers could be removed, reloaded and replaced in less than 4 minutes.



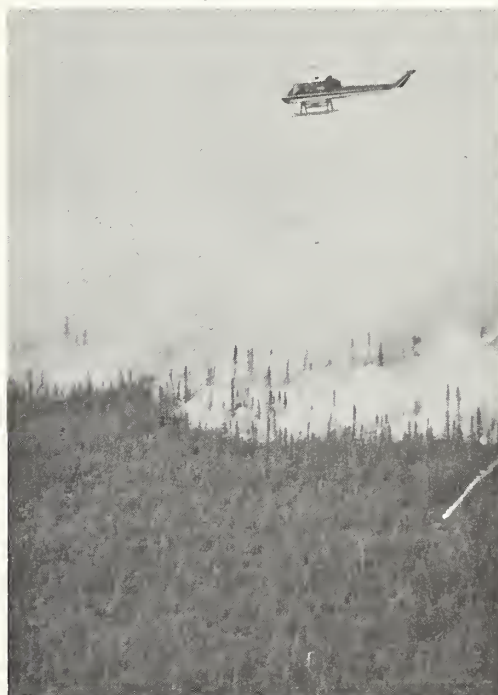
*Figure 2.--Loading dispensers.*

By dropping from sufficient altitude and speed so that the grenades began burning and dropping burning particles above the tree canopy, up to a 40-foot long strip could be ignited with each grenade (fig. 3). This ignition pattern may not occur in all fuels because when dry, the black spruce-tundra fuel type of interior Alaska appears to be very easy to ignite.

#### Bergman Creek Fire (No. 8840)

The dispenser was used next on the Bergman Creek Fire. In approximately 2 hours, 168 AN-M14 grenades were used to burn out 3.5 miles of line along a small stream which tied into the Alatna River. Fuels in this area were much more difficult to ignite because the area had burned several years earlier and most of the fine fuels were gone. Also, the weather had turned cloudy and the relative humidity was over 60 percent. Several loads of retardant were

spread to lengthen the line beyond where the small stream became too narrow to be an effective barrier. The retardant line is in the upper center of figure 4.



*Figure 3.--Drop altitude for grenade ignition above tree canopy.*



*Figure 4.--Bergman Creek Fire showing natural barriers and retardant line.*



The significant part of this operation was that, by taking advantage of favorable winds, a portion of line was constructed using only aircraft with retardant and aerial ignition, the control operation was accomplished with no one on the ground.

#### Rocky Bottom and Double Point Mountain Fires (No. 8632 and No. 8837)

The dispensers were next used on the Rocky Bottom Fire (fig. 5). A total of 163 AN-M14 grenades were used to burn out approximately 5 miles of line on this fire. Twenty-four ASP grenades were also dropped some distance inside the fireline to evaluate how well they worked for area ignition in the interior Alaska fuel type. The BLM people involved in the evaluation did not feel that this grenade had an application for the type of burning they need to do and that it was undesirable to store and handle because of the Class A fuze.

The burnout on the Rocky Bottom Fire was done using three types of control lines. Streams and wet green strips were tied together with retardant and handline. Six loads of retardant were dropped by PB4Y and C-119 aircraft and a 17-man crew constructed about 1,600 feet of handline. The sector boss in charge of the crew made the following comments on the aerial firing system:

"The helicopter/grenade approach is very fast when compared to hand firing. I estimate three times as fast when compared to a hand crew.



*Figure 5.--Burnout to wet green areas on Rocky Bottom Fire.*

"This method is more efficient in that fires may be set within the interior of the burnout area immediately prior to or after ignition along the line. Such action lends itself to a more successful operation in that heat buildup and suction can be created to pull the fire inward from the line. This approach can be accomplished in a much more safe and accurate manner than by hand crew."

The retardant line held until a handline could be constructed the following day. The burnout consumed the heavy fuels to the extent that there were no problems holding the line even though an adverse wind of up to 20 miles per hour occurred on the second day. Twenty-four of the AN-M14 grenades were also dropped on the Double Point Mountain Fire to burn out an island of fuel inside the line but an evaluation of the effectiveness of this drop was not made.

A malfunction occurred while dropping on the Rocky Bottom Fire when a roll pin holding a control rod knob worked out and lodged against the fiberglass nose cover. This stopped the control rod halfway through the cycle which resulted in the control box indicator light remaining on as it normally does when the dispenser is empty. At this time the helicopter departed the drop site to refuel and there was apparently enough vibration to dislodge the pin which completed the cycle and dropped the grenade. This happened just outside the fireline and was quickly picked up by the ground crew and there was little damage. It could have been disastrous, however, if the grenade had fallen unnoticed some distance from the fire, or in the refueling area. A few grenades remained in the dispenser and were removed when the helicopter returned to the loading site. Several wraps of tape were placed over the pins to prevent them from working out and it was recommended that a mirror be installed that would allow the pilot or operator to check the racks for unleased grenades prior to landing.





## PRESCRIBED BURNING - SLASH

Personnel on the Bonners Ferry Ranger District, Idaho Panhandle National Forests, expressed an interest in aerial ignition for slash burning. The District purchased a supply of AN-M14 grenades and the dispenser was mounted on the Forest's contract Bell G3B-1 helicopter. The equipment was demonstrated using dummy grenades and the pilot was briefed on procedures. Later in the fall, the District used the aerial system and 100 grenades to ignite all (except along the roads) of a 110-acre block (fig. 6).

They found that attainable accuracy was excellent, and the pilot and operator had little difficulty selecting and hitting fuel concentrations (fig. 7). To take advantage of as much grenade burning time as possible after it reaches the fuel, they recommend dropping from the lowest safe altitude (fig. 8).

The cost of the helicopter on this 110-acre block was about \$150 and included ferry time to the area.

## PRESCRIBED BURNING - BIG GAME WINTER RANGE

In recent years several Forests in northern Idaho have been working on improving the quality and quantity of available browse for big game animals by running a light fire through brush fields in early spring. This is done just after the snow melts and before new plant growth begins. The fire is carried by the dry grass, broken fern and leaves. Little or no control is needed and the major expense is ignition. Many areas are steep and inaccessible and, therefore, ground ignition methods are expensive.

The Delayed Action Ignition Device (DAID), developed by the Australians, has been used successfully and is relatively inexpensive. The first reported use was on the Clearwater National Forest in 1971.<sup>2/</sup> The DAID's are loaded in a metal box on the outside of

<sup>2/</sup> Fultz, M. Clark. Aerial ignition of ground fuels by delayed action ignition device (DAID) in big game winter range rehabilitation, July 1971.



Figure 6.--Slash burn ignited with aerial firing system.



Figure 7.--Ignition on selected fuel concentrations.



Figure 8.--Ignition and burning of AN-M14 grenade above fuels.



a special cutdown helicopter door (fig. 9). A striker pad is also mounted on the special door. Several of the DAID's are pulled from the box and ignited one at a time on the striker pad and then dropped immediately.

The helicopter is flown at about 100 feet above ground level and at a ground speed of approximately 40 miles per hour. At this speed the DAID's are ignited and dropped as fast as possible. A flight to fill in the ignition gaps is usually needed to attain a continuous flame front. The 40 mi/h flying speed is desirable to maintain good flight characteristics in the small helicopters being used.

In the report Fultz noted that the person igniting the DAID's should wear goggles because the matchhead sometimes fragmented and a piece of the burning material could be thrown into the operator's eye. Gloves should also be worn as the DAID must be held close to its head when striking and occasionally a person will wind up with the burning matchhead material sticking to his thumb.

Although the evaluation covered in the report was quite limited, Fultz was able to compare the rate and cost of aerial and ground ignition methods. The rate for aerial ignition was approximately 67 acres per man-hour with an on-the-ground cost of \$1.67 per acre. Ground ignition was done with fusees at the rate of about 5 acres per man-hour and an on-the-ground cost of \$2.58 per acre. Helicopter time was included in both costs as it was used to ferry people into the area where the ground ignition method was used. The cost per acre did not include preburn planning which was higher with the ground method. This was due mainly to the extra coordination needed because of the greater number of people involved.

In the spring of 1973 the firing system developed by MEDC was used in a limited trial on browse burning. Both the military AN-M14 and the ASP grenades were dropped. Burning conditions were marginal and although approximately 200 acres were burned, a comparative evaluation of the two systems was not possible.



Figure 9.--DAID firing system.

#### CURRENT USE AND PLANS

Two additional systems, utilizing the recommended design changes, were assembled early in FY 1974. One of these systems was installed on a contract Hughes 500 helicopter on the Los Padres National Forest. This installation required some modification to the mounting bracket. The Hughes 500 does not have cross tubes to attach the racks to and this particular machine was not equipped with a cargo rack. The bomb shackles were not used and the modified mounting bracket was attached directly to the cargo hook. Another set of dispensers was installed on the Pacific Northwest Region's (R-6) Hiller 12E4 at Troutdale, Oregon. Neither Region had an opportunity to use the systems on wildfire. During the summer of 1973, the third dispenser system was sent to Alaska at the request of BLM, but was not used because of a light fire season. After this unit was returned from Alaska, it was used on the prescribed burning in R-1 mentioned earlier in this report.





A browse burning project covering about 4,000 acres was planned for the spring of 1974 using the XM118 dispenser and AN-M14 grenades. However, due to adverse weather conditions little browse burning was done and no use was made of either grenades or dispensers.

During the 1974 season, one unit will remain on the Los Padres National Forest and the unit in R-6 will be transferred to the State of Washington, Department of Natural Resources, for use on prescribed burns.

The current cost of parts and equipment needed to assemble a dispenser system is approximately \$1,700. This includes two XM118 dispensers at \$600 each and two bomb shackles at \$152 each. The remainder of the cost is for the control unit and mounting bracket. This total cost does not, however, include the fabrication and assembly of the control unit and bracket which will vary depending upon local conditions. Some machine work is required on the mounting bracket and knowledge of the assembly of electronic parts is necessary in making the control unit.

In a recent contact with the U. S. Army Weapons and Munitions Command at Rock Island, Illinois, they indicated that the dispensers could be obtained on a temporary loan of up to 1 year at a time which would reduce the total cost of each system by \$1,200. Procurement assistance, including federal stock numbers, will be provided by the WO Division of Fire Management or MEDC.

Where plans can be made prior to the use of the aerial firing system and a

particular helicopter is selected, Federal Aviation Administration (FAA) Form 337 (appendix 1) should be completed and the installation inspected and approved by the FAA. Field units having a need to obtain or use these systems should work through the WO Division of Fire Management. Field Use Instructions are available from MEDC (see appendix 2).

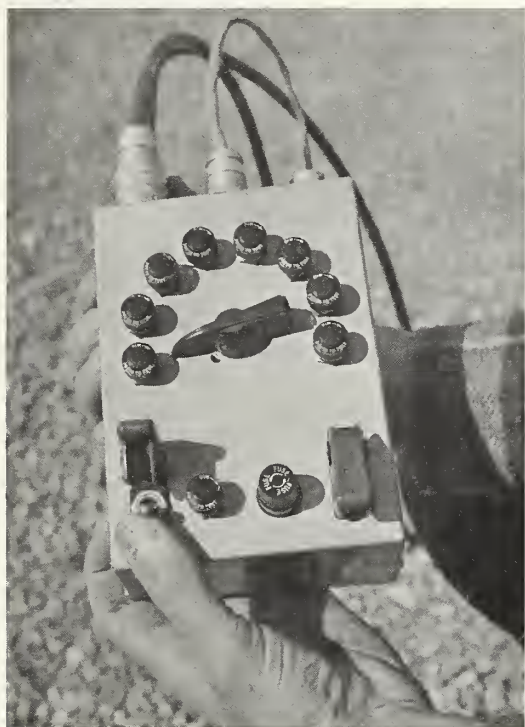
#### SUMMARY OF RESULTS

In all, 19 miles of burnout was accomplished on three wildfires, using hand dug line, retardant, and natural barriers for control. At the end of the evaluation the firing team made a list of recommendations which included the following:

1. A five-man team, including pilot, should be trained to use the dispenser and grenades.
2. The team leader should be a trained firing specialist and do all the grenade dispensing.
3. The AN-M14 incendiary grenade should be used for burnout. The ASP grenade should not be used because the wide variation in pattern does not make it possible to burn close to control lines and the Class A fuze creates handling problems.
4. The dispenser controls and mounting bracket should be modified so that four racks can be mounted on the Bell 204 or 205 helicopters which would allow a firing team to work independently on large remote fires. The large helicopter could also be used to ferry holding crews.



As a result of the recommendations, the controls have been redesigned to include an eight-position rotary switch that allows the use of up to four dispenser racks (fig. 10).



*Figure 10.--Dispenser control box.*

The mounting bracket has also been changed so that it will fit a greater number of helicopters. Complete construction drawings (MEDC-522) are available from the Center.

The main advantage in aerial ignition for slash burning is the speed and flexibility and the added safety of not having to work people in the interior of the burn in heavy slash where foot travel is slow and hazardous.

Personnel on the Bonners Ferry Ranger District felt that for planning purposes on prescribed burns, one grenade per acre is a good number to use. They also recommended using four racks instead of two which would enable them to extend the length of the mission. Such a firing system fully loaded would weigh about 220 pounds, so depending upon the weight of the firing specialist and the density altitude, a four rack system is marginal for small helicopters.

On browse burns using the XM118 dispenser, the helicopter can be flown several hundred feet higher above ground level than when dropping the DAID's and gives a little extra margin of safety should an aircraft malfunction occur.

#### CONCLUSIONS

1. The aerial firing system is a useful tool for burnout on wildfires and ignition on various types of prescribed burns and meets the general requirements established for an airborne ignition system.

2. The achievable accuracy is sufficient to allow firing from roads, hand-line, retardant line, streams, wet areas, and other natural barriers.

3. Aerial ignition makes it possible to burn large areas or long segments of line rapidly when burning conditions are the most favorable.

4. The military AN-M14 thermate incendiary grenade can be used to ignite many forest fuels.





## RECOMMENDATIONS

1. MEDC should continue liaison with the military to be aware of the availability of surplus dispensers and new developments with incendiary grenades.
2. Continue the use of AN-M14 incendiary grenades for various types of firing. If sufficient field need develops, design or development of incendiary grenades specifically for ignition of forest and range fuels should be started.
3. Dispensers and grenades should be placed in several strategically located fire caches in western Regions. Contract helicopters should be designated to be used for firing and the necessary FAA approval obtained prior to the fire season.
4. Several three- to five-man special firing teams should be trained in the safe operation of the aerial firing equipment and firing techniques.



DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION <b>MAJOR REPAIR AND ALTERATION</b> <b>(Airframe, Powerplant, Propeller, or Appliance)</b>				Form Approved Budget Bureau No. 04-R0601 <hr/> FOR FAA USE ONLY OFFICE IDENTIFICATION	
INSTRUCTIONS: Print or type all entries. See FAR 43.9, FAR 43 Appendix B, and AC 43.7-1 (or subsequent revision thereof) for instructions and disposition of this form.					
1. AIRCRAFT	MAKE Bell		MODEL 47G3B1		
	SERIAL NO. 2809		NATIONALITY AND REGISTRATION MARK N73931		
2. OWNER	NAME (As shown on registration certificate) Johnson Flying Service, Inc.		ADDRESS (As shown on registration certificate) Box 1366, Missoula, Montana 59801		
3. FOR FAA USE ONLY					
The data incorporated herein complies with applicable airworthiness requirements and is approved only for the above described aircraft subject to conformity inspection by a person authorized in FAR 43.7(b). <i>H. Earl Morgan 3-21-74</i> <i>RM-6ADO-5</i>					
4. UNIT IDENTIFICATION				5. TYPE	
UNIT	MAKE	MODEL	SERIAL NO.	REPAIR	ALTERATION
AIRFRAME	***** (As described in item 1 above) *****				X
POWERPLANT					
PROPELLER					
APPLIANCE	TYPE				
	MANUFACTURER				
6. CONFORMITY STATEMENT					
A. AGENCY'S NAME AND ADDRESS		B. KIND OF AGENCY		C. CERTIFICATE NO.	
Johnson Flying Service, Inc. P. O. Box 1366 Missoula, MT 59801		U.S. CERTIFICATED MECHANIC		C.R.S. # 1331 Limited Bell Helicopter	
		FOREIGN CERTIFICATED MECHANIC			
		X CERTIFICATED REPAIR STATION			
		MANUFACTURER			
D. I certify that the repair and/or alteration made to the unit(s) identified in item 4 above and described on the reverse or attachments hereto have been made in accordance with the requirements of Part 43 of the U.S. Federal Aviation Regulations and that the information furnished herein is true and correct to the best of my knowledge.					
DATE 3-21-74		SIGNATURE OF AUTHORIZED INDIVIDUAL <i>John Light</i>			
7. APPROVAL FOR RETURN TO SERVICE					
Pursuant to the authority given persons specified below, the unit identified in item 4 was inspected in the manner prescribed by the Administrator of the Federal Aviation Administration and is <input checked="" type="checkbox"/> APPROVED <input type="checkbox"/> REJECTED					
BY	FAA FLT STANDARDS INSPECTOR	MANUFACTURER	INSPECTION AUTHORIZATION		
	FAA DESIGNEE	X REPAIR STATION	CANADIAN DEPARTMENT OF TRANSPORT INSPECTOR OF AIRCRAFT		
DATE OF APPROVAL OR REJECTION 3-21-74		CERTIFICATE OR DESIGNATION NO. C.R.S. 1331		SIGNATURE OF AUTHORIZED INDIVIDUAL <i>John Light</i>	



## NOTICE

Weight and balance or operating limitation changes shall be entered in the appropriate aircraft record. An alteration must be compatible with all previous alterations to assure continued conformity with the applicable airworthiness requirements

8. DESCRIPTION OF WORK ACCOMPLISHED (If more space is required, attach additional sheets. Identify with aircraft nationality and registration mark and date work completed.)

Built and installed on helicopter landing gear cross tubes, 2 incendiary grenade dispensers. Tubes are of 2" x .035" wall 1040 steel. Brackets are mild steel and are clamped to the cross tube with aerosol clamps.

Electrical control box is held and operated by the firing specialist in the passenger seat of the helicopter. See attached photo.

The dispensers are jettisonable in case of emergency.

Unit Wt. 78 lbs. with a minus moment of 322.

All work done in accordance with 43.13-2 Chapter 7 Section 2

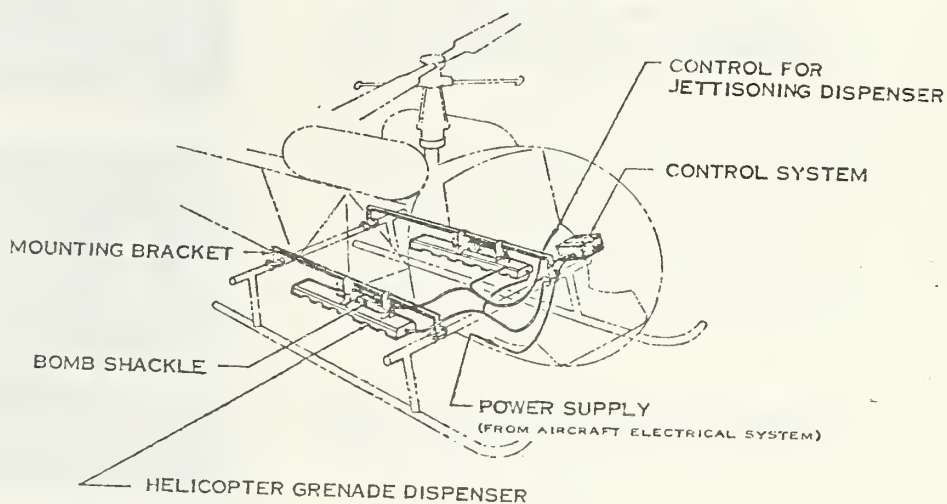


Figure 7.-- Helicopter grenade dispenser system schematic.

☐ ADDITIONAL SHEETS ARE ATTACHED

U.S. G. P. O. 1572/720-694 545/1303



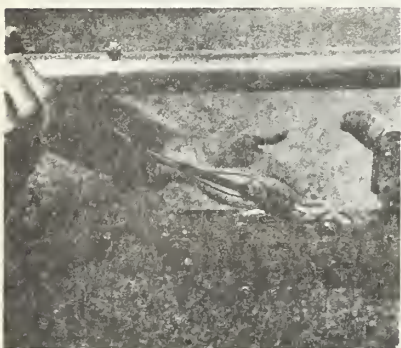
# FIELD USE INSTRUCTIONS

## Helicopter Incendiary Grenade Dispenser

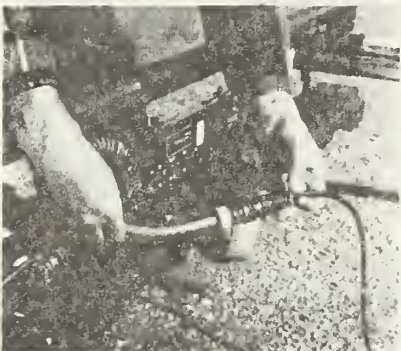


### MOUNTING—

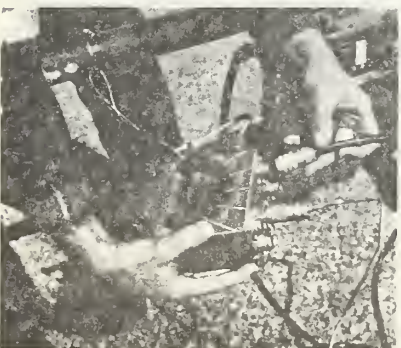
1. *Attach mounting bracket and bomb rack to helicopter cross tubes or skids.*



2. *Attach quick-disconnect lanyards securely to mounting bracket. Be sure the lanyard is shorter than the electrical cable. The connector will not separate if the pull is on the electrical cable.*



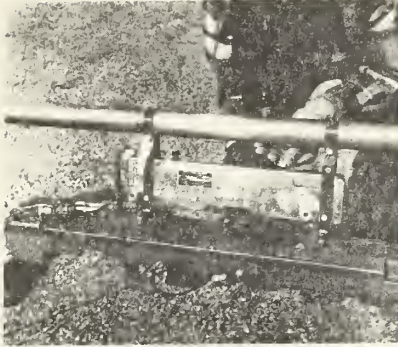
3. *Connect wires from bomb rack to cargo hook release wiring.*



4. *Connect power supply wires from control unit to helicopter electrical system and connect cables from control unit to dispensers. With the power on, check to be sure that bomb racks will release the dispensers and the electrical connector will separate. Also check to be sure that the firing switch cycles the dispensers.*

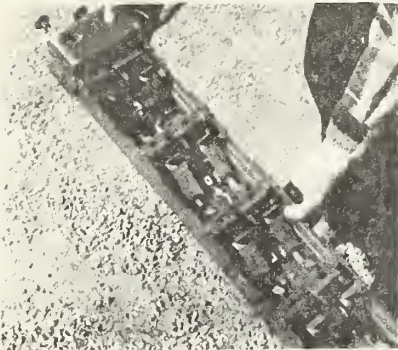




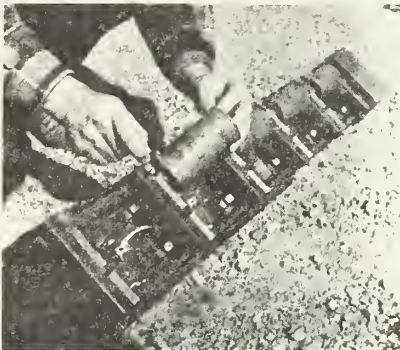


## LOADING—

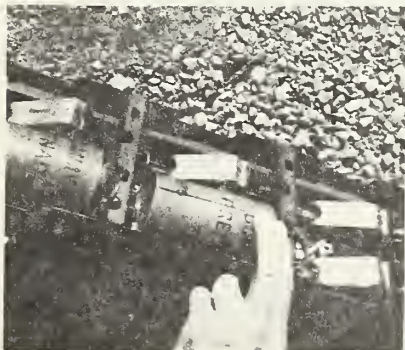
5. a. *Check that main electrical circuit is off.*
- b. *Check that master arm switch on control unit is off.*
- c. *Check dispensers to be certain that no unreleased grenades are present. Remove dispensers from the bomb racks unless there is adequate room to load from beneath the helicopter.*



6. *Push the solenoids until both control rods are fully extended.*



7. *Place the grenades in the dispenser with the fuze end forward and pull ring in the cutout in the bulkhead. On the right side the fuze levers should rest against the tab protruding from the bulkhead. On the left side the fuze levers should rest against the outside of the dispenser.*



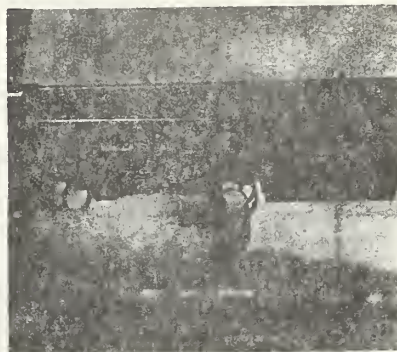
8. *Push the grenade against the ejection spring until the latch snaps over the rim at the base of the grenade. Continue until the desired number of grenades are loaded.*



9. *Attach the dispensers to the bomb rack. It is desirable to use three persons, two to hold the dispenser while the third latches the bomb rack.*



10. *Pull the grenade safety pins. Note: If clearance beneath the dispensers is not adequate, the pins may be pulled before the dispensers are mounted. Handle the dispensers with extra care if the grenade pins have been pulled.*



11. *Just prior to flight push in the control rods. This cocks the dispenser.*



#### FIRING—

Determine the desired flight speed and drop interval prior to takeoff.

12. *When over the area to be fired move the master arm switch to the "on" position.*







13. *Depress the firing button at the desired interval. An indicator light for each row of grenades in the dispenser will remain on when all of the grenades in that row have been ejected.*



#### UNLOADING--

14. *If grenades remain in the dispenser after the mission is complete, immediately insert the safety pins. Before attempting to unload the dispenser, be sure that the main helicopter electrical circuit and control unit master arm switch are off.*
15. *Remove the dispensers from the bomb racks and carry them a safe distance from the helicopter and other flammables. **Unload the row in which the fuze levers lie along the outside of the dispenser first.** Starting with the rear grenade, hold the fuze lever firmly against the grenade body and then push the solenoid to release the grenade.*
16. *After the grenade is released from the dispenser, hold the fuze lever firmly and check to be sure the safety pin is fully inserted and secured before setting the grenade down. Move forward, remove the next grenade in the same manner until all grenades in that row have been removed.*



The fuze levers in the next row lie along the centerline of the dispenser and are more easily held after the outside row of grenades have been removed. Remove the grenades one at a time, again starting from the rear.





